ANALYSIS OF THE AIR FORCE EQUIPMENT REPLACEMENT FORECASTING METHOD

REPORT AF503T1

Douglas J. Blazer

LMI
GOVERNMENT CONSULTING

NOVEMBER 2005

NOTICE:

THE VIEWS, OPINIONS, AND FINDINGS CONTAINED IN THIS REPORT ARE THOSE OF LMI AND SHOULD NOT BE CONSTRUED AS AN OFFICIAL AGENCY POSITION, POLICY, OR DECISION, UNLESS SO DESIGNATED BY OTHER OFFICIAL DOCUMENTATION.

Executive Summary

The Air Force forecasts requirements to replace current in-use Air Force–managed support equipment. There are two needs for the replacement forecast:

- To provide budget estimates for equipment needs 1–7 years into the future.
- To execute equipment buy (and repair) actions.

The Air Force currently uses a few methods to forecast replacement requirements, but the forecasts are generally based on item manager– (IM-) and equipment specialist– (ES-) loaded replacement factors. The replacement factors estimate the percentage of current inventory that needs to be replaced. For example, if an item has 100 units in use and a 10 percent replacement factor, its replacement forecast is 10 (i.e., 0.10 × 100), meaning 10 of the 100 equipment items will need to be replaced in a given year. D200C, the current computation system, then projects the replacement (10 in our example) for the requirement.

Our research seeks to determine the accuracy of the current Air Force support equipment replacement forecast, and, if it is not accurate, recommend ways to improve both the budget and execution forecast accuracy.

After comparing the Air Force forecasts to the actual equipment replacements, our analysis indicates the Air Force has no effective system to forecast equipment replacement accurately. The current system forecasted more than $350 million of requirements that never materialized, and did not forecast $568 million in equipment failures. The current computation also does not compute requirements for some items with valid replacement needs.

The current system does not collect sufficient data to forecast replacements; however, it is not clear if any system could forecast replacement requirements accurately enough to develop a bottom-up (at the national stock number [NSN] level) budget forecast for the program objective memorandum (POM) years, even if the system collected all the relevant data. More likely, the Air Force could develop an aggregate forecast—by major air command (MAJCOM) or type of support equipment—that would more accurately forecast the replacement dollars needed, but not the individual items that need to be replaced.

We believe the Air Force can significantly improve its replacement computation for execution (buy and repair) by using current replacement requisition data to update the computation. Based upon this assumption, we pose the following recommendations:

- Develop a program that will ensure valid replacement requisitions are accurately included in the computation.
- Through analysis, develop an aggregate budget forecast for support equipment (including war readiness materiel [WRM]) replacement requirements, and determine if it is more accurate than the current forecast method.
- Execute (buy and repair) to actual requirements. Do not constrain execution to items that are computed as a budget requirement in the previous year's computation (or in the *Depot-Purchased Equipment Maintenance* [DPEM] repair brochure).
- Identify equipment replacement data requirements and determine the capabilities of commercial Advanced Planning System (APS) and Enterprise Resource Planning (ERP) systems to collect the data necessary to accurately forecast equipment replacement requirements.

Contents

Acknowledgments vii

Chapter 1 Introduction 1-1

- Approach 1-1
- Basic Conclusions 1-2
- Report Organization 1-3

Chapter 2 Measuring Forecast Accuracy 2-1

- Current System 2-1
- Measuring Forecast Accuracy 2-5
- Analysis Summary 2-8

Chapter 3 Proposals for Improving Replacement Forecasting 3-1

- Near-Term Proposals 3-1
- Long-Term Proposals 3-4

Chapter 4 Conclusions and Recommendations 4-1

- Conclusions 4-1
- Recommendations 4-1

Appendix A Replacement Criteria Codes

Appendix B Abbreviations

Tables

Table 2-1. Current Equipment Replacement Rates 2-1
Table 2-2. Example of Projected Requirements 2-4
Table 2-3. Air Force Historical Replacement Analysis 2-5
Table 2-4. Air Force Replacement Forecast Compared to Backorders 2-6
Table 2-5. Air Force Replacement Forecast Current Forecast Accuracy 2-8
Table 3-1. Example 1, Replacements with a Forecast 3-2
Table 3-2. Example 2, Replacements without a Forecast 3-2

Acknowledgments

We gratefully appreciate the efforts of many who helped complete this study. The folks at the Warner Robins Air Logistics Center (542 GSUM/GBMM) and the Operations and Sustainment Support Group at Wright-Patterson Air Force Base provided their expertise and great patience and were instrumental in our efforts. Special thanks go to Cathy McIntosh, who tirelessly instructed and guided our efforts. We could not have done it without her.

Chapter 1
Introduction

The Air Force forecasts requirements to replace current in-use Air Force–managed support equipment. There are two needs for the replacement forecast:

- To provide budget estimates for equipment needs 1–7 years into the future.
- To execute equipment buy (and repair) actions.

The Air Force equipment computation systems, D039 and D200C, compute requirements by comparing authorizations to available assets (any deficit or authorization shortage is a requirement), projecting future mission changes (unit activations), and forecasting replacement needs. The replacement forecast projects equipment purchase needs a lead-time away, so the computation forecasts from 1 to 7 years in the future to place the replacement buy today.

Air Force equipment policy is to buy (or repair) to meet actual needs (e.g., an authorization shortage or future replacement). The Air Force does not buy (nor repair) equipment to stock based on an anticipated future need.

The current system has a few methods to forecast replacement requirements, but the forecasts are generally based on item manager– (IM-) and equipment specialist– (ES-) loaded replacement factors. The replacement factors estimate the percentage of the current inventory that will need to be replaced. For example, if an item has 100 units in use and a 10 percent replacement factor, its replacement forecast is 10 (i.e., 0.10 × 100), meaning 10 of the 100 equipment items will need to be replaced in a given year. The current computation system (D200C) then projects the replacement (10 in our example) for the requirement.

Our research seeks to determine the accuracy of the current Air Force support equipment replacement forecast, and, if it is not accurate, recommend ways to improve both the budget and execution forecast accuracy.

APPROACH

We first measured the current system's forecast accuracy. Using historical (March 2003) Air Force equipment computation (D200C) data, we compared forecasted replacement requirements to the actual replacement needed (as measured by replacement requisitions from the users) in the appropriate lead-time. For example, the March 2003 computation forecasted a need to replace (i.e., buy now) an item that is forecasted to fail a procurement lead-time away (i.e., 1–2 years in the future).

Looking at a 16-month window for the actual replacement requisitions, we sought to answer the following research questions:

- How many items with a replacement forecast actually have a replacement need (a requisition)?
- How many items have a replacement requisition (no authorization shortage; the current asset is used until receipt of the replacement), but do not have a replacement forecast? Because there is no authorization shortage or forecast (and no additive), the computation does not recognize the replacement requirement.
- How many items have no forecast but have an "authorization shortage" replacement requisition?[1]

We then explored alternative approaches for improving the forecast accuracy. We also identified the data the future Air Force enterprise systems should collect to improve the support equipment replacement forecasting.

BASIC CONCLUSIONS

The current Air Force system does not accurately forecast equipment replacement needs. It frequently forecasts requirements that never materialize, and does not forecast requirements for some items that actually fail. It also does not compute requirements for some items with valid replacement needs.

In addition, the current system does not collect the data elements needed to compute an accurate forecast. For example, the current system does not collect data on the current age of in-use equipment, operating hours, or past repair history.

D039 collects historical condemnations (assets leaving the Air Force inventory in "H" condition[2]). Eight quarters of this data is used to calculate the condemnation rate and then mechanically calculate the replacement factor. The problem is most assets leave the Air Force in "F" condition and are not counted in the condemnation rate. Another problem is 2 years is not enough historical data to accurately determine a condemnation rate for equipment items that last 8–25 or more years.

Even if the system collected all relevant data, it is not clear any system could forecast replacement requirements accurately enough to develop a bottom-up (at the NSN level) budget forecast for the program objective memorandum (POM) years. It is more likely the Air Force could develop an aggregate forecast by major air command (MAJCOM) or by type of support equipment that would more accurately forecast the replacement dollars needed, but not the individual items that need to be replaced.

[1] This partly measures the accuracy of the forecast; however, even though these items were not forecasted, they will be included in the requirement because they have an authorization shortage.

[2] See Appendix A for replacement code criteria and definitions.

The bottom line is the Air Force can significantly improve its replacement computation for execution (buy and repair) by using replacement requisition data to update the computation. The Air Force should base equipment buy and repair decisions on current identified needs (i.e., a replacement backorder), not on often unreliable forecasted needs.

REPORT ORGANIZATION

The remainder of this report is organized into three chapters and two appendixes.

- In Chapter 2, *Measuring Forecast Accuracy*, we describe and measure the accuracy of the current system.
- In Chapter 3, *Proposals for Improving Replacement Forecasting*, we propose methods for improving forecast for execution and budgeting.
- In Chapter 4, *Conclusions and Recommendations*, we summarize our findings and present our recommendations for the Air Force to improve replacement forecasting and requirement computations.
- In Appendix A, we define the different replacement criteria codes used throughout this report.
- In Appendix B, we define the acronyms used throughout this report.

Chapter 2
Measuring Forecast Accuracy

In this chapter we describe the current system used by the Air Force to forecast and compute replacement requirements. We also measure the accuracy of the current forecasts.

CURRENT SYSTEM

For the majority of equipment items, replacement requirements are forecasted based on replacement factors entered by the IM/ES team. The computation forecasts replacement needs by multiplying the item-specific replacement rate by the number of in-use pieces of equipment. About 39 percent of Air Force–managed support equipment have a replacement factor greater than zero.[1]

Table 2-1 provides the replacement rates currently (March 2005) in the D200C database.

Table 2-1. Current Equipment Replacement Rates

Replacement factor range	Number of SGMs
0 or no replacement factor	27,432
1–0.0399	1,892
0.04	38,291
>0.04	2,516
Total	70,131

Note: SGM = sub-group master.

The predominant replacement rate is 0.04, which represents a 25-year life span for the equipment. A 0.04 replacement rate assumes 4 percent of the current inventory needs to be replaced each year. Therefore, it would take 25 years to replace every item.

Appendix A identifies the replacement code criteria for all the Air Force–managed equipment. The majority (59,195 of the 70,131 total items, or 84 percent) are coded as "G" or "A," manual file maintenance, for which the IM/ES team enters the replacement factor. An "A" code tells the system to use the IM/ES team factor no matter what the system may calculate; a "G" code tells the system to use the IM/ES factor only if it doesn't have sufficient data to calculate a replacement factor using historical in-use and condemnation data. The next most often used code, "H," indicates there is insufficient condemnation data to calculate a replacement factor.

[1] This data does not include vehicles.

There are 2,377 items (3 percent) that have sufficient data for a computed condemnation rate; the IM/ES team did not manually change the factor for these.

Equipment managers realize, that even with complete historical data, it is difficult to forecast which and how many items will fail and need replacement. But it is impossible to forecast replacements by national stock number (NSN) without complete and reliable data. The current system forecast is based on how many of each NSN are in the in-use inventory and eight quarters of actual condemnations. The automated system does not collect the age of the items in the inventory, the operating hours or repair history for the current inventory, or the expected life expectancy[2] of the equipment.

For most equipment items, the Air Force estimates the replacement factor for each NSN and then computes replacement requirements for each NSN for each year of the computation. The extended cost (*escalated unit price × the number of replacement units needed*) calculated across all NSN replacement requirements for each year becomes the replacement budget estimate. Although equipment managers understand the accuracy of a system that computes requirements by individual NSN is limited, they need to project out-year requirements for the budget.

The Air Force also uses the individual NSN replacement forecasts to project buy and repair requirements. Again these requirements are a forecast of future failures.[3] Because Air Force policy is not to stock equipment in anticipation of a need, the Air Force must execute (buy and repair) to actual needs—a current backorder or mission change (e.g., new activation) requirement. This policy does not take into consideration the long lead-time items (some take more than 12 months to produce after being obligated to contract), however. If the replacement for an actual shortage or backorder must be in place by year of execution, the Air Force will be late to fulfill the need.

Execution forecasts need to be at the NSN level; however, there may not be a need for out-year organization and maintenance (O&M) item forecasts at the NSN level.[4] Out-year NSN forecasts should not dictate near-term execution. The Air Force should not preclude buying or repairing an item with an immediate need (a backorder) because it was not included in the budget forecast.[5] The Air Force

[2] The "expected life expectancy" is a file-maintainable field, but the majority of the items do not have it file-maintained. Unless the replacement criteria code is "B" or "D" (Projected Usage and Life Expectancy, or PULE, rule) (there are only 45 cases for these codes), the system does not use expected life expectancy to formulate the replacement requirement.

[3] We make a distinction between "forecasts" for execution (near term buy and repair decisions) and forecasts for the budgets (resource and capacity planning purposes).

[4] Investment item budgets are submitted by NSN.

[5] In practice, some repair managers will not repair support equipment items unless they are included in the Depot Production Equipment Maintenance (DPEM) brochure (repair DPEM budget forecast), even if it has an immediate need.

should execute based on the most current data available, not based on a projection built that is 1–3 years old.

The bases (i.e., users) generate three kinds of replacement requisitions:

- Requisitions with an existing authorization shortage (advice code 6G)
- Requisitions that will replace the existing asset upon receipt of the new asset (advice code 6S and 6R)
- Replacements for embedded equipment that does not have a reported authorization or in-use asset at the component level (advice code 62).

Requisition data is not automatically input to the computation, so only 6G requisitions (what is known as an "authorization hole") is the only requirement included in the computation.

Replacement forecasts calculated by a replacement factor will never duplicate a shortage, because factors are applied only to in-use assets that are aligned to actual authorizations. These are recalculated every quarter using the latest in-use data. Several special allowances will not compute replacements (e.g., 000 and 048). In addition, the replacement forecast does not start until the second program position and does not count until the buy position, which is the minimum lead-time, or 18 months from the reported period.

If there is an authorization shortage at the time the data is passed from the Air Force Equipment Management System (AFEMS) to D039, a forecast is not computed. If the in-use asset is turned in before the end of the execution year, the replacement forecast allows the requirement to be included in time for the actual occurrence. The sample below (Table 2-2) is from the March 2003 D200C computation for NSN 1005007105599. This sample NSN has a gross requirement of 2,928 and assets of 2,815, which leaves a shortage of 113 in the reported position. The reported position shows the asset position at the time the computation was loaded. There are also 66 additive requirements within this position. These assets are for type requirement 80, which is *not* an additive input-due-to-replacement requirement. There are no replacement requirements set within the reported position (see the row labeled "Replenishment" and blank in the column labeled 2/03).

Table 2-2. Example of Projected Requirements

SGM 1005 00 710 5599 I&S 1005 00 710 5599 WR ALC Div T IMS 3G			Display PRA Projected Requirements and Assets Requirements FY04/05-04U I BUD CD CTL 8170100600					AD200.C4D108ZP Cur: 27 Oct 05 1459 Updated 10 Dec 03 1545 As of: 31 Mar 03 U TM NM Mount, Tripod, Machin STD PRC 584		
Requirement	Rpt. 2/03	Current OP 4/04	Buy 4/07	Budget (Bud) 4/08	Bud+1 4/09	Bud+2 4/10	Bud+3 4/11	Bud+4 4/12	Bud+5 4/13
Gross requirements									
Air Force initial (init.)	1,671	1,671	1,671	1,671	1,671	1,671	1,671	1,671	1,671
Cap. init.	0	0	0	0	0	0	0	0	0
ANG init.	852	852	852	852	852	852	852	852	852
AFR init.	339	339	339	339	339	339	339	339	339
WRM	0	0	0	0	0	0	0	0	0
Replenishment		3	8	10	11	11	11	11	11
Additive	66	66	66	66	66	66	66	66	66
Total	2,928	2,931	2,936	2,938	2,939	2,939	2,939	2,939	2,939
In use	2,642	2,642	2,642	2,642	2,642	2,642	2,642	2,642	2,642
In place	0	0	0	0	0	0	0	0	0
Wholesale serviceable	67	67	67	67	67	67	67	67	67
Wholesale unserviceable	84	84	84	84	84	84	84	84	84
Found on order	22	22	22	22	22	22	22	22	22
Total	2,815	2,815	2,815	2,815	2,815	2,815	2,815	2,815	2,815
Net requirements		116	121	123	124	124	124	124	124
Initial		0	0	0	0	0	0	0	0
Replacement		116	121	123	124	124	124	124	124

Note: OP is operating position and WRM is war readiness materiel.

The replacement factor for this NSN is 0.0006. The replacement forecast is calculated using the following formula:

Replacement factor × *time factor* × *sum of in-service and warehouse assets applied, reapplied, and allocated at each program position*.

The reported position never calculates a replacement requirement; therefore, this quantity will always be blank. The current operating position (the third column in Table 2-2) calculates the replacement at

$$0.0006 \times 1.75 \times 2{,}793 = 3.$$

The buy year (the fourth column in Table 2-2) calculates the replacement as

$$0.0006 \times 4.75 \times 2{,}793 = 8.$$

The replacement requirement never considers shortages (authorization holes) in the computation, only assets currently on hand or available.

Replace-upon-receipt requisitions do not generate a requirement in the computation unless the computation includes a replacement forecast or an additive. If there is no replacement factor or additive in the computation, a valid need (as represented by a current customer backorder; a 6S, 6R, or 62 replacement requisition) is not included in the computation.

The Air Force asked us to include a method to forecast and compute war readiness materiel (WRM) replacement forecasts in our review of replacement forecasts. The current legacy system (D039) prohibits forecasting for WRM (use code D) replacement. The theory is, WRM equipment is not used day to day, it is stored awaiting use in a contingency; so WRM does not wear out and should not need replacement. That is why there is no mechanical process to "forecast" replacements (via a replacement factor) for WRM equipment. Units with WRM equipment can submit replacement forecasts, but the computation does not compute requirements for 6R, 6S, and 62 requisitions. Further, selected WRM equipment items will need replacement even though they are not used day to day, because some equipment wears out even without use (tents, for example), and some unused (that is, stored) equipment becomes obsolete. For these reasons, the Air Force should have a way to forecast replacements for WRM equipment.

MEASURING FORECAST ACCURACY

To measure the accuracy of the current equipment replacement forecasts, we compared the forecasted replacements from the computation (replacement factors and additives) to the actual failures, as measured by the user replacement requisitions (backorders [BO]). Using the March 2003 computation results, we compared the forecasted replacements (to buy a lead-time away) to the actual replacement requisitions lead-time away (March 2004–July 2005). Table 2-3 presents our results.

Table 2-3. Air Force Historical Replacement Analysis

D200C total replacement forecast	70,353
Value of D200C total replacement forecast	$784.4 million
D200C replacement forecast NO BO to support	50,466
Value of D200C replacement forecast NO BO to support	$305.3 million
Forecast with 6G BO	10,753
Value of forecast with 6G BO	$139.9 million
Forecast with 6R GS BO	9,134
Value of forecast with 6R GS BO	$294.3 million

D200C forecasted more than 70,000 units needed to be replaced, for a requirement value of more than $784 million. More than 50,000 of these items ($350 million) had no replacement requisition within the forecasted lead-time window (FY05). So, there were replacement requisitions for approximately 20,000 units ($434 million), nearly 11,000 ($140 million) of which were replacements with an authorization shortage (6G requisitions) and 9,000 ($294 million) of which were replacements without an authorization shortage. Nearly 45 percent ($350 million of $784 million) of the forecasted replacement requirements by NSN *did not materialize*, and $140 million of forecasted replacement requirements materialized and were included in the computation.

Next we looked at the number and amount with an actual replacement requisition that did not have a forecasted requirement. Table 2-4 presents our results.

Table 2-4. Air Force Replacement Forecast Compared to Backorders

Beginning 6G quantity	34,985
Value of beginning 6G quantity	$399.6 million
Beginning 6R, 6S, and 62 quantity	50,900
Value of beginning 6R, 6S, and 62 quantity	$874.7 million
Remaining 6G BO quantity not in computation	24,232
Value of remaining 6G BO quantity not in computation	$259.8 million
Remaining 6R_6S_62 BO not in computation	41,267
Value of remaining 6R_6S_62 BO not in computation	$568.0 million

There were nearly 35,000 ($400 million) replacement requisitions with an authorization shortage (6G requisition) and nearly 51,000 ($875 million) replacement requisitions with no authorization shortage (6R, 6S, and 62 requisitions). Of the 51,000 with no authorization shortage, approximately 41,000 ($568 million) had no forecast or additive in the computation. There also was no computed requirement for $568 million of equipment with a valid base level need.

Using the same NSN example presented in Table 2-2, we see that, for the buy year, there are only eight replacement requirements calculated and no replacement additives loaded on this computation (March 2003). In fact, there are 35 6G and 15 6R or 6S replacement requisitions for this NSN within the lead-time window. This means 50 replacement backorders need to be filled; but the March 2003 D200C computation did not forecast enough to fill these needs. The valid requisition replacements are not included in the computation.

Of the $400 million of requisitions with an authorization shortage, $260 million had no forecast in the computation; however, the computation does include these items because there is an authorization shortage.

We are now ready to answer our research questions from Chapter 1.

- How many items with a replacement forecast actually had a replacement need (a requisition)?

  Our analysis of the March 2003 data analysis shows that 55 percent ($434 million of $784 million) of forecasted replacements actually had replacement requisitions. $350 million of replacements forecasted never materialized.

- How many items had a replacement requisition (no authorization shortage; the current asset is used until receipt of the replacement), but did not have a replacement forecast?

  The March 2003 analysis shows that, $568 million of the $875 million, or 65 percent, shortage replacement requisitions were not forecasted (via a replacement factor or an additive). These items do not show a requirement in the computation. Because there is no authorization shortage and no forecast (and no additive), the computation does not recognize the replacement requirement.

- How many items had no forecast but had an "authorization shortage" replacement requisition?

  $260 million of the replacement requisitions (with an authorization shortage) had no forecast and no additive requirement. This measures part of accuracy of the forecast; however, even though these items were not forecasted, they will be included in the requirement because they have an authorization shortage.

We conducted a similar analysis using March 2005 computation data and compared the forecast to the March 2005 replacement requisition data. We wanted to see how many actual 6G replacement requisitions had a forecast and how many "no authorization shortage" (6R, 6S, and 62) requisitions were not included in the computation. Table 2-5 provides the results.

Table 2-5. Air Force Replacement Forecast Current Forecast Accuracy

	Advice code	
	6G	6R, 6S, or 62
Valid replacement BO quantity	10,783	24,914
Value of valid replacement BO	$104.2 million	$496.7 million
D200C replacement forecast	5,166	9,307
Value of D200C replacement forecast	$68.2 million	$276.8 million
No forecast, no additive in computation	5,617	15,450
Value of no forecast, no additive in computation	$436.0 million	$216.0 million

As of March 2005, D200C had approximately 6,000 ($436 million) requirements that were not forecast; however, because they have an authorization shortage, they are included in the computation.

There were 25,000 ($497 million) current valid (6R, 6S, or 62) requisitions, of which more than 15,000 ($216 million) were not recognized by the computation as a requirement (no forecast or additive).

ANALYSIS SUMMARY

The current system forecast is less than 50 percent accurate at the NSN level. More than 45 percent of forecasted needs never materialized, and the system failed to forecast 65 percent of the actual replacement needs (requisitions). In the aggregate, the March 2003 computation forecasted $784 million replacement requirements for FY05, but there was $1.3 billion ($875 million 6R, 6S, and 62, plus $400 million 6G) of replacement requisitions in FY05. The $1.3 billion includes all replacement requisitions that *existed* within the lead-time window, so it includes backorders generated *earlier* than the lead-time window that have not yet been satisfied.

Further research showed $305 million ($96 million 6G backorders and $209 million of 6S, 6R, and 62 backorders) of the replacement requisitions actually occurred in the lead-time window projected in the March 2003 computation. More than $1 billion of the existing backorders represent a backlog of requirements. In aggregate dollars, the computation underestimated the existing requirement ($784 million compared to $1.3 billion) and overestimated the amount of backorders ($784 million compared to $305 million) that generated in the lead-time period. In addition, there are valid needs that are not included in the computation. Looking at the March 2005 data, there were 15,000 ($216 million) unrecognized user requisitions.

We draw three lessons from our analysis:

- The current budget forecast approach is not accurate and should not be used to execute buy and repair requirements. Using the budget forecast, the Air Force will buy (or repair) items it does not need, and not buy (or repair) items users actually need. The Air Force should use only actual requirements (replacement requisitions, authorization shortages and weapon system projections) to execute buy and repair decisions.

- An aggregate dollar value forecast would be easier to forecast accurately than individual NSN replacements. In addition to not providing an accurate replacement forecast at the NSN level, the current NSN forecast does not provide an accurate aggregate estimate of the funding needed for replacement.

- The Air Force should ensure replacement requisitions are appropriately reflected in the computations; the computation should include replacement needs without an authorization shortage.

Chapter 3
Proposals for Improving Replacement Forecasting

In this chapter, we describe some near-term and longer-term proposals to improving the Air Force's replacement forecast and computation.

NEAR-TERM PROPOSALS

We have two proposals for improving replacement forecasting in the near term.

1. *Develop a program that ensures all items with a valid replacemen*t (no authorization shortage) *requisition are included in the requirement*.

   We propose to query the Stock Control System (D035) and identify all valid[1] 6R, 6S, and 62 replacement requisitions for Air Force–managed equipment items and create a management product and the appropriate transaction input to allow the IM to load additives into the computation. The management product would compare the sum of the current replacement requisitions to the current forecasted requirement, with the difference loaded as an additive. If there is no current forecast amount, the management product (and the load transaction) would indicate the number of replacement requisitions that should be loaded as an additive.

   Table 3-1 and Table 3-2 illustrate two examples of this forecasting method. The program would run at least quarterly and be timed so the input transactions could be included in the quarterly computation.[2]

[1] "Valid" in this instance is an authorization with an in-use asset, including a decremented value. For example, if organization identification (ORGID) 123 has four authorized assets, two in-use assets, and three 6R/6S backorders, only two 6R/6S backorders would be considered valid for replacement additives because the remaining authorizations already reflect a hole.

[2] Because additives stay in for at least 12 months, it is necessary to identify previous additive input for reduction or early deletion. A change in the condemnation rate could result in the calculation of more replacements, or an ORGID that had a valid 6R/6S backorder the previous quarter may be forced to "let go" of an in-use asset and now reflect a hole. The sheer volume of missing replacement requirements may require a mass change to D200C; however, a mass change could only be accomplished during file maintenance in March and September.

Table 3-1. Example 1, Replacements with a Forecast

Replacement requisitions 6R/6S/62	FE 4400	2
	FE 5284	1
Forecast requirements 20% replacement rate		1
Additive load		2

Table 3-2. Example 2, Replacements without a Forecast

Replacement requisitions 6R/6S/62	FE 5685	3
	FE 4840	2
	FE 5237	2
Forecast replacements		0
Additive load		7

2. *Develop an aggregate method to forecast requirements.*

Replacement forecasts are needed for the budget and to execute a requirement. Execution forecasts must be listed by individual NSN, and should be based on actual requirements (a replacement requisition, an authorization shortage, or a new mission requirement as identified by a weapon system program [WSP]). Budget forecasts do not need to be presented by NSN; they need a relatively accurate estimate of the dollars needed to buy (or repair) replacement requirements.

Even with complete and relevant data, replacement forecasts by NSN will not be accurate enough to execute by NSN. Instead, we propose the Air Force develop an aggregate forecast of required dollars (for buy and repair) to the level of detail required for budgeting and capacity and procurement planning.

Current documentation for investment budgets, at least for major procurements (more than $3 million), requires the number of replacements to be procured for that end item of equipment using the budget and budget+1 year's funding. Although, some investments are spent on programs that are less than $3 million, the bulk of the investment dollars are tied to major programs that do require NSN-level details. Even O&M items need to reflect out-year replacements at lower levels for long lead-time items (that is, production lead-time is 24 months or greater) that require near-term execution for long-term delivery. So an aggregate measure may not be feasible for some items.

We propose a regression-based analysis to relate historical replacement requirements by dollars to some factor like amount of in-use inventory. The regression would be broken down by MAJCOM or type of equipment (e.g., aerospace ground equipment [AGE], communications, test,

or calibration). The result would be a forecast of replacement requirements for the budget years, years 1 to 7 in the future.[3]

There is precedent for an aggregate forecasting method for budget purposes; the civil engineers forecast real property facility maintenance based on a historical percent of the value of real property. Reportedly, the aggregate method is more accurate than the facility-by-facility forecast and was accepted by the Air Force and OSD as *the* budgeting forecast method.

If we can develop a relatively accurate aggregate forecast method, we would suggest the Air Force stop using the replacement factors and rely on the users to identify replacement needs (via requisitions) a lead-time away. Bases currently use requisitions to forecast replacement needs for budget code 9 equipment items. User-forecasted replacement needs—which coincides with the Support Equipment Transformation (SET) effort in which MAJCOMs control what equipment is bought and when—would prove more accurate than the current system's 50 percent accuracy rate. User forecasts also correspond to our near-term proposals. There would be no replacement factor forecast; rather there would be an automated input of a replacement additive requirement from replacement requisition data.

Using the additive requirement would not require system changes, other than the program we intend to develop in our near-term proposals. As an added capability, we suggest the Air Force develop a way to time-phase requirements; that is, identify a date the authorization and replacement requisition takes affect. This would make it easier for MAJCOM and base users to submit a replacement requisition a lead-time away.[4]

Our proposals apply to all support equipment, including war readiness materiel equipment.[5] Our proposals will ensure all replacement requisitions are included in the computation. In addition, our proposals allow additives for special replacement programs, like replacing obsolete (or expired) equipment.

Our proposals eliminate the need for replacement factors, which by current policy cannot be used for WRM equipment. They develop an aggregate dollar-value forecast for WRM replacement equipment similar to the support equipment forecast. We will derive a separate aggregate forecast just for WRM equipment, because it will differ from strictly in-use equipment.

[3] The aggregate estimate would be more accurate than today's NSN-by-NSN forecast. If it is not proven more accurate, the Air Force will not implement it.

[4] Although this feature is nice to have, it is not necessary to implement this proposal.

[5] WRM managers already submit replacement requisitions for WRM equipment. The programs we propose will create transactions to load additives for replacement WRM requisitions.

In summary, our near-term proposals

- will develop a more accurate aggregate budget forecast for replacement requirements;
- allow the user to determine when to replace an item, which coincides with the SET objectives;
- eliminate the need for using replacement factors;
- execute (repair and buy) only to actual identified needs;
- automate the loading of relevant requisition data to modify the computation; and
- apply to WRM replacements as well as support equipment replacements.

LONG-TERM PROPOSALS

The Air Force is in the process of purchasing and implementing a commercial Enterprise Resource Planning (ERP) system and Advanced Planning System (APS) as part of the Enterprise Combat Support System (ECSS). The Air Force should define the data it needs to more accurately compute equipment replacement requirements. Even with better data, we are skeptical that a system that forecasts replacements by NSN will be accurate enough for buy and repair execution decisions; however, better data will certainly improve the forecast and should provide data for capacity, procurement, and workload planning if not for actual buys or repairs.

We list below the type of data needed for forecasting equipment replacement.[6] The new Air Force ECSS should include this data to improve equipment replacement forecasting and requirements computation:

- *Lifetime condemnation data, including the cause of the condemnation*. Data should indicate if an item was in an accident or had battle damage versus if it was condemned because it outlived its useful life.
- *Age of each piece of equipment in the current inventory.* Most reliability models forecast failures (need for replacement) based on the age of the equipment rather than an across-the-board replacement rate for all items, regardless of age. Note there are various ways to measure age, not just when the item was first fielded (e.g., in terms of operating hours). Even if the level of data by operating hours cannot be obtained and maintained, "first-fielded" data would be an improvement over today's system.

[6] We are unsure if this data is generally included (and used) in today's commercial ERP systems. Nonetheless the Air Force should document its equipment replacement forecast data requirement needs for the new APS and ERP systems.

- *Expected life span*.
- *Repair history*. This would include the amount and cost of all repairs to date. Air Force policy is to repair only up to 75 percent of the acquisition cost. The repair history would include any repairs that extend the life of the item. In addition, the frequency of repair (i.e., failure) would identify "bad actors," items that cost more to maintain than they are worth.
- *Obsolescence rate*. Some items will need to be replaced due to obsolescence, not wear.

Other data elements may be needed as input to whatever reliability models the ERP system requires. For example, operating hours (how many hours the equipment has been in-use), minimum and maximum life spans, probability of failure, etc. ERP systems have the potential to improve the Air Force equipment repair and replacement requirements forecast and computation; but it will take time to collect the necessary historical information to populate the ERP system. So, even when the ERP is implemented, it will take several years to collect the data to make the ERP replacement forecast useful.

Chapter 4
Conclusions and Recommendations

CONCLUSIONS

The current system does not accurately forecast replacement requirements. It forecasted $350 million items that do not need replacement, and did not forecast $568 million items that need to be replaced.

The March 2005 computation does not include $215 million in valid replacement requirements. The current computation does not include requisition data to update its forecasts, unless manually input as an additive by the item manager.

The Air Force currently does not have the necessary data to improve its replacement forecast accuracy at the NSN level; however, forecasting equipment replacement requirements by NSN is a difficult task, even if the system collected all the relevant data.

The Air Force does not need to forecast replacement requirements for O&M–funded items by NSN to develop a budget forecast; it only needs an aggregate estimate of dollars needed.

Our proposals apply equally well to WRM replacement requirements.

RECOMMENDATIONS

Develop a program that ensures valid replacement requisitions are accurately included in the computation. **OPR: 542 MSUG/GBMM**

- Ensure replacement requisitions with no authorization shortage (Advice Code 6R, 6S, and 62) are included in the computation.
- Modify the computation's forecast when replacement requisitions with an authorization shortage are received.

Conduct an analysis to develop (and determine if it is more accurate) an aggregate budget forecast for support equipment (including WRM) replacement requirements. **OPR: 542 GSUM/GBMM**

Execute (i.e., buy and repair) to actual requirements. Do not constrain execution to items that computed as a budget requirement in the previous year's computation (and in the DPEM repair brochure). **OPR: 542 MSUG/GBMM**

Identify equipment replacement data requirements and determine the capabilities of commercial APS and ERP systems to collect the data needed to accurately forecast equipment replacement requirements. **OPR: LMI**

Appendix A
Replacement Criteria Codes

Table A-1 defines the replacement criteria codes and identifies the number of sub-group masters (SGM) for each replacement code.

Table A-1. Replacement Criteria Codes

Code	Definition of code	Number of SGMs
A	File maintenance by item manager (IM)	5,965
B	Projected Usage and Life Expectancy (PULE) rule	45
C	Computed condemnation rate	2,377
E	Optimum Reliability through Effective Management (ORTEM)—Replacement quantity input as additive requirement	109
F	Technical Order (TO) Factor = 0, replacement quantities input as additive requirements	111
G	Manual file maintenance until enough condemnation data is available. When sufficient data is there, will be in “C”	53,230
H	System default—Mechanically entered when a new item is introduced or inadequate condemnation and in-use data is available. (The replacement criteria code will change to C when sufficient data is available.)	8,292
Blank	No data entered	2
Total		70,131

Appendix B
Abbreviations

AFEMS	Air Force Equipment Management System
AGE	aerospace ground equipment
APS	Advanced Planning System
DPEM	Depot Production Equipment Maintenance
ECSS	Enterprise Combat Support System
ERP	Enterprise Resource Planning
ES	equipment specialist
IM	item manager
IMS	inventory manager
MAJCOM	major air command
NSN	national stock number
O&M	organization and maintenance
OP	operating position
ORGID	organization identification
POM	program objective memorandum
PPEM	Depot Production Equipment Maintenance
PULE	Projected Usage and Life Expectancy
SET	Support Equipment Transformation
SGM	sub-group master
WRM	war readiness materiel
WSP	weapon system program

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
11-2005	Final	

4. TITLE AND SUBTITLE
Analysis of the Air Force Equipment Replacement Forecasting Method

5a. CONTRACT NUMBER
GS-00F-0026M

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Blazer, Douglas J; Author

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

LMI
2000 Corporate Ridge
McLean, VA 22102-7805

8. PERFORMING ORGANIZATION REPORT NUMBER
LMI-AF503T1

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
HQ USAF/ILGM
1030 Air Force Pentagon
Washington, DC 20330-1030

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
A Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The Air Force forecasts requirements to replace current in-use Air Force–managed support equipment. There are two needs for the replacement forecast: to provide budget estimates for equipment needs 1–7 years into the future, and to execute equipment buy (and repair) actions. The current system does not collect sufficient data to forecast replacements; however, it is not clear if any system could forecast replacement requirements accurately enough to develop a bottom-up (at the national stock number [NSN] level) budget forecast for the program objective memorandum (POM) years, even if the system collected all the relevant data. More likely, the Air Force could develop an aggregate forecast—by major air command (MAJCOM) or type of support equipment—that would more accurately forecast the replacement dollars needed, but not the individual items that need to be replaced.

We believe the Air Force can significantly improve its replacement computation for execution (buy and repair) by using current replacement requisition data to update the computation.

15. SUBJECT TERMS
Replacement forecasting method; forecasting; NSN

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE	Unclassified Unlimited	32	Nancy E. Handy
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED			19b. TELEPHONE NUMBER *(include area code)* 703-917-7249